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Mapping and Prediction of Coal Workers' Pneumoconiosis with Bioavailable Iron Content in the Bituminous Coals

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Running Title: Mapping and Predicting Coal's Toxicity

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Abbreviations: BAI: Bioavailable iron; COPD: Chronic obstructive pulmonary disease; CWP: Coal workers' pneumoconiosis; USGS: US Geological Survey; NSCWP: National Study of Coal Workers' Pneumoconiosis.

Outline of section headers:

Abstract:

Based on the first National Study of Coal Workers' Pneumoconiosis (CWP) and the US Geological Survey database of coal quality, we show that the prevalence of CWP in seven coalmine regions correlates with levels of bioavailable iron (BAI) in the coals from that particular region [correlation coefficient $r=0.94$, $p<0.0015$]. CWP prevalence is also correlated with contents of pyritic sulfur ($r=0.91$, $p<0.0048$) or total iron ($r=0.85$, $p<0.016$), but not with coal rank ($r=0.59$, $p<0.16$) or silica ($r=0.28$, $p<0.54$). BAI was calculated using our model taking into account chemical interactions of pyrite, sulfuric acid, calcite, and total iron. That is, iron present in coals can become bioavailable by pyrite oxidation, which produces ferrous sulfate and sulfuric acid. Calcite is the major component in coals that neutralizes the available acid and inhibits iron's bioavailability. Therefore, levels of BAI in the coals are determined by the available amounts of acid after neutralization of calcite and the amount of total iron in the coals. Using the linear fit of CWP prevalence and the calculated BAI in the seven coalmine regions, we have derived and mapped seven thousand coal samples' pneumoconiotic potencies. Our studies indicate that levels of BAI in the coals may be used for the prediction of coal's toxicity, even before large-scale mining.